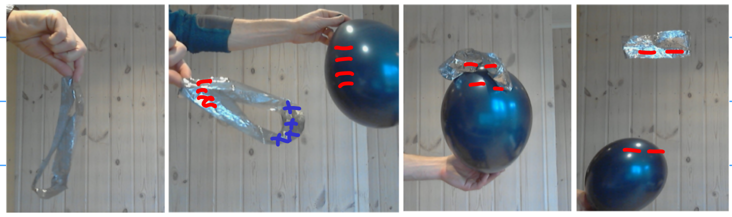
Ladning og elektrisk felt

Eksamen 2020:

Ballong og metallfolie, forklar:

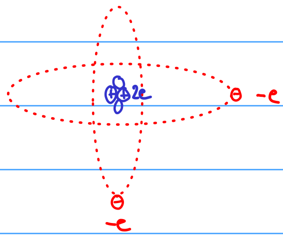


1. Metallfolien henger fritt.
2. Ballongen har blitt gnidd mot en ullgenser. Metallfolien tiltrekkes av ballongen.
3. Folien og ballongen er i kontakt et lite øyeblikk.
4. Folien svever over ballongen.

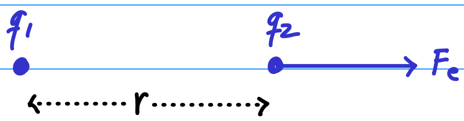
Ladning q eller Q. $[q] = C$ = coulomb

Et proton: $e = 1{,}60 \cdot 10^{-19}\,C$

Eks: He-atom:



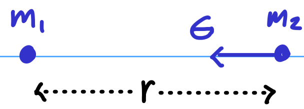
Coulombs lov:



$$F_e = k_e \frac{q_1 q_2}{r^2}$$

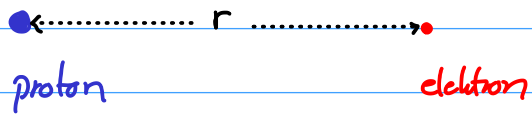
$k_e = 8{,}99 \cdot 10^9 \frac{Nm^2}{C^2}$: Coulombkonstanten.

(Newtons gravitasjonslov:



$$G = \gamma \frac{m_1 m_2}{r^2}$$
)

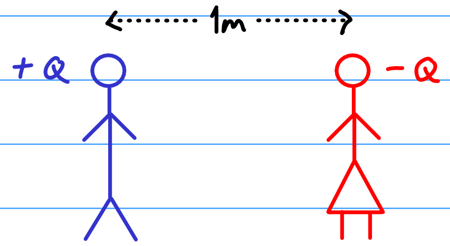
Er elektriske krefter store eller små?



$$\frac{|F_e|}{G} = \frac{k_e \frac{e^2}{r^2}}{\gamma \frac{m_e m_p}{r^2}} = \frac{k_e e^2}{\gamma m_e m_p}$$

$$\approx 10^{39}$$

Eks: Arne gnir kinnet sitt mot hodet til Berit.
Anta at 0,1% av elektronene i Arnes hode ender opp på Berits hode.



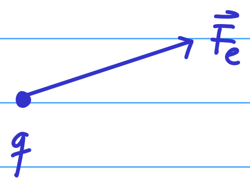
Kraft mellom dem? $F_e = k_e \cdot \frac{Q^2}{r^2} = \ldots \approx 10^{20}\,N$ (!!!)

Konklusjon: Tallet 0,1% er altfor stort.
I praksis er det ekstremt god balanse i ladning.

Elektrisk felt

Def.: $\vec{E} = \frac{\vec{F}_e}{q}$

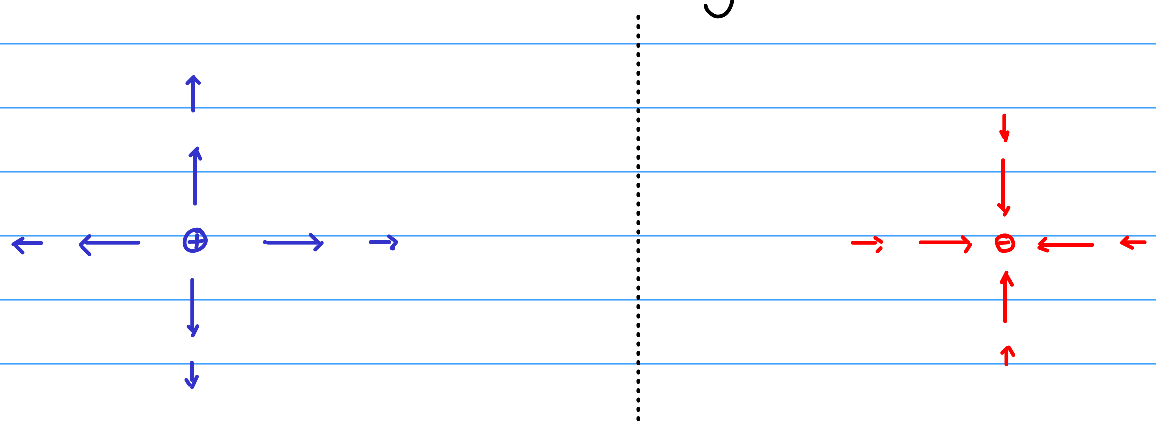
$\vec{F}_e = q\vec{E}$



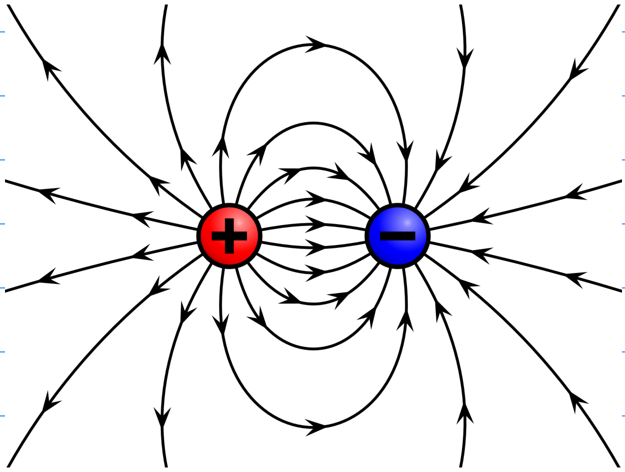
$|\vec{E}| = E =$ feltstyrke

$[E] = \frac{N}{C}$.

Eks: $\vec{E}$-felt fra en punktladning

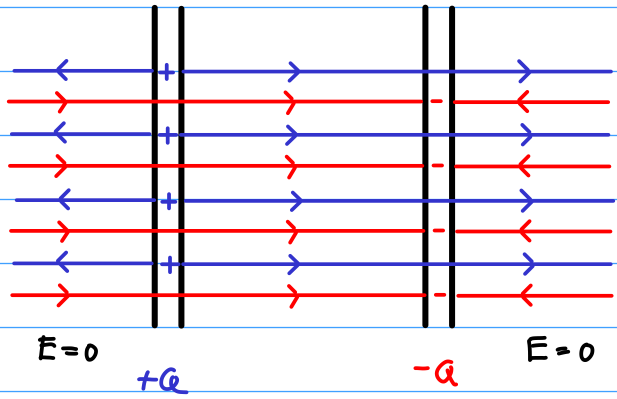


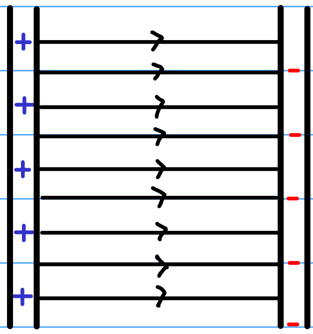
Eks: Feltlinjer to ladninger



https://en.wikipedia.org/wiki/Electric_field

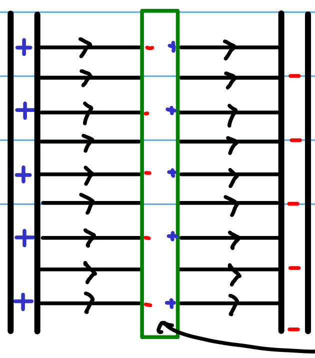
Eks: To ladde plater - kondensator





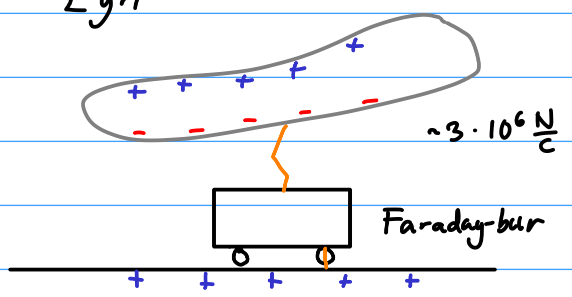
Hva skjer hvis vi putter et metallstykke mellom platene?

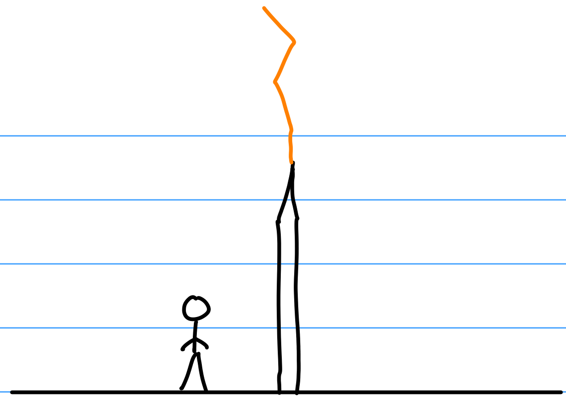
└ elektrisk leder



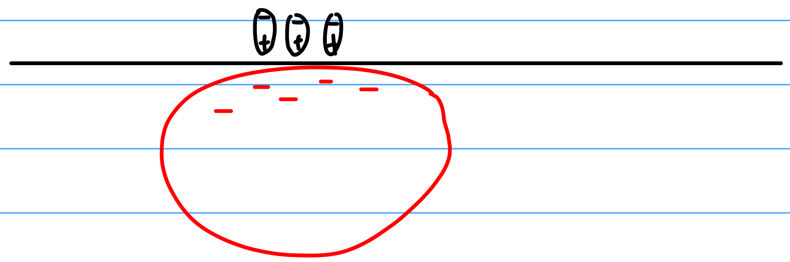
E=0 i lederen! Faraday-bur

Eks: Lyn



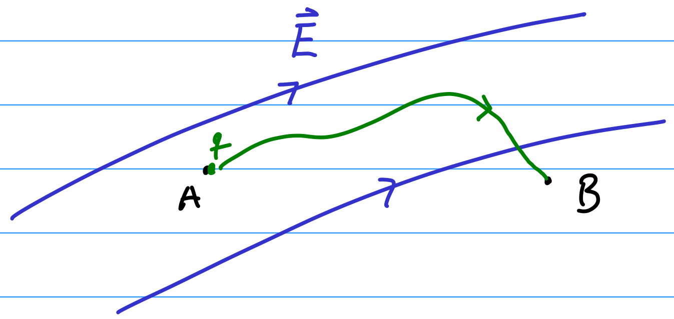


Eks: Hvorfor fester ballongen seg til taket?
Polarisering!



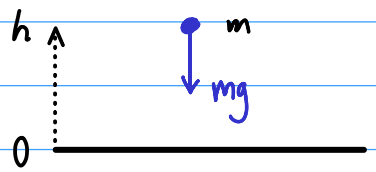
Potensiell energi og spenning

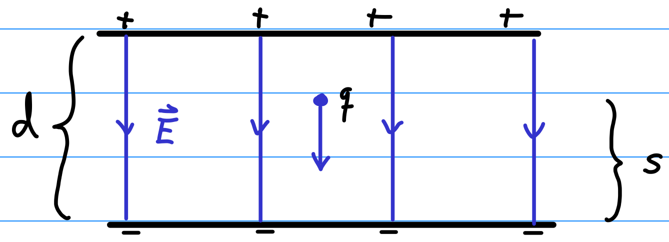
Spenning = potensialforskjell = $U_{AB} = \frac{W_{AB}}{q} = \frac{\text{arbeid som de el. kreftene utfører når } q \text{ flyttes fra A til B}}{q}$



Enhet: $[U_{AB}] = \frac{J}{C} = V$

Homogent felt:





Arbeid for å løfte massen en høyde h: W = kraft · forflytn.

$= mg \cdot h$

$= m \cdot gh$

$= E_p$ = pot. energi

Arbeid for å løfte ladningen en høyde s: $W = qE \cdot s$

$= E_p$ = pot. energi

Spenningen mellom platene:

$U = \frac{qEd}{q} = Ed$

$E = \frac{U}{d} = \frac{\text{spenning}}{\text{avstand mellom platene}}$

$W = m \cdot gh$

$W = q \cdot U_{AB}$

Tenk på spenning som gh, altså som en slags "høydeforskjell" i det elektriske feltet!

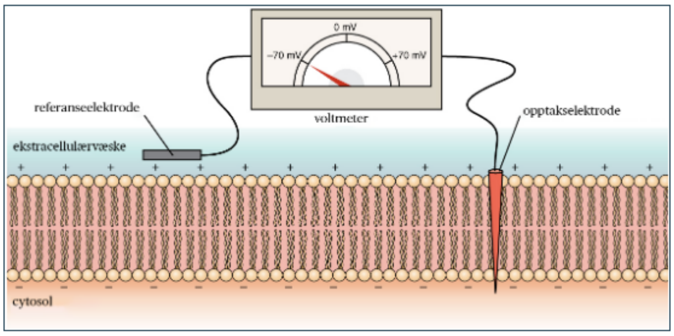
Enhet elektrisk felt: $[E] = \frac{N}{C} = \frac{V}{m}$.

Eks: Membran-potensial

Hva er E i membranen?

$$E = \frac{U}{d} = \frac{70\,mV}{7\,nm}$$

$$= 10^{7}\,\frac{V}{m}$$



OpenStax/OpenStax CNX, Anatomy and Physiology. 12. feb. 2019

$d = 7\,nm$

Kondensator – kapasitans

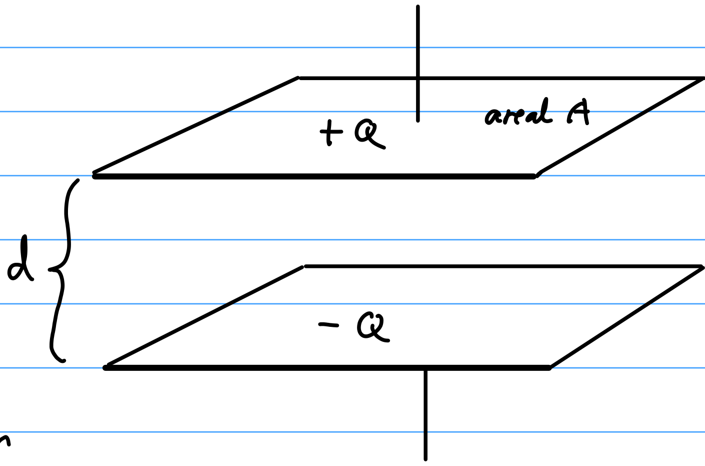
Kapasitans: $C = \frac{Q}{U}$

Viser seg: $C = \frac{\varepsilon_r \varepsilon_0 A}{d}$

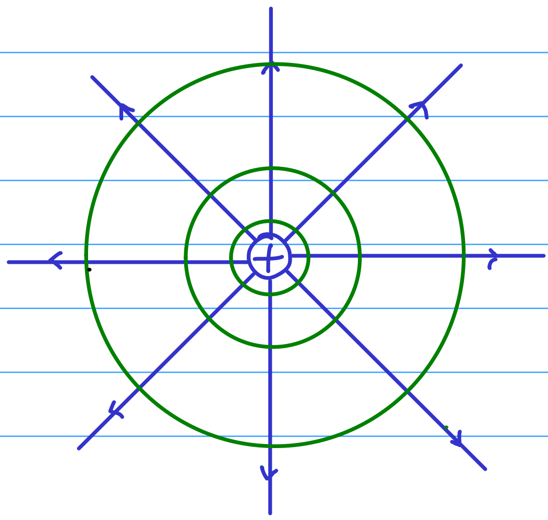
$$\varepsilon_0 = \frac{1}{4\pi k_e} = 8{,}85 \cdot 10^{-12}\,\frac{C}{Vm}$$

ε_r : relativ permittivitet

$$[C] = \frac{C}{V} = F = \text{farad}$$

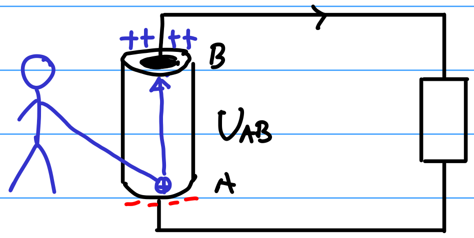


Potensiell energi i et ikke-homogent felt:



ekvipotensialflater: flater med konst. potensial: "høydekurver".

Batteri - spenningskilde



En "ekstern" (f.eks. kjemisk) kraft pumper ladning "opp" fra A til B.